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range between indoor and outdoor temperatures. Lord Kelvin actually proposed to heat a house by a reversed heat engine or refrigerating machine. I am not aware whether this has actually been tried in practise.

By the efficiency of a boiler we mean the ratio of the energy, contained in the hot water and steam into which it has been converted, to the amount of heat that may be realized by burning the coal. This suffices to indicate the performance of the boiler, while that of the engine is a separate thing, and suffices to compare the performance of the engine with that of a perfect engine, limited as it is by the second law of thermodynamics. Mr. Forbes casts doubt upon Carnot's cycle being the most perfect one, but that was thoroughly proved by Carnot to be the case. In fact the gas-engine and the Diesel, which approach most nearly to the Carnot cycle, have the highest efficiency that has been attained. Mr. Forbes is correct in pointing out the fact that the efficiency of electric heating is unity, a fact which interests the consumer, who in this rare case knows that the meter can not do him an injustice, and yet, for all that, this is not a cheap method of heating. Electricity *can* compete with the ice-man.

ARTHUR GORDON WEBSTER

#### REVERSAL OF THE SODIUM LINE

TO THE EDITOR OF SCIENCE: On a recent visit to a large plate-glass factory in the vicinity of Charleston, West Va., I had the good fortune to note the reversal of the well-known sodium line "D." The instrument used was a small pocket direct-vision spectroscope, which I carry with me on technical trips.

The furnace was a 200-ton plate-glass type, gas fired; and the reversal was noted at the peep-hole near the charging end, and shortly after the introduction of a fresh charge of the "mix." The reversal was noted in the case of two furnaces, one of these giving a *steady* reversal, and one giving a *wavering* and *intermittent* reversal. The phenomenon was noted both by myself and also by three distinguished technical friends attendant on the

trip. Of course the reversal of the sodium lines is frequently observed in the electric arc, but this is the first instance in my experience that I have noted such reversal in a *fuel-fired furnace*. The temperature of the furnace was probably approximately 3,000° F.

The observation may be more common in the experience and observation of others; but if this brief note should prove of value, the writer will be glad to answer any detailed questions regarding this rather unique matter. I have long held the opinion that the spectroscope has not been—and is not yet—used for its full technical worth in the practical arts.

CHARLES S. PALMER

UNITED FUEL GAS CO.,  
CHARLESTON, WEST VA.

#### THE CARNEGIE FOUNDATION AND RESEARCH IN THE COLLEGES

In a paper on college government and the teacher's salary, in the 14th annual report of the Carnegie Foundation for the Advancement of Teaching, the statement is made that much of what passes for research in American universities is only imitation research, which is detracting from the quality of the teaching to which the students are entitled. The conclusion is drawn, by inference at least, that the large sums of money spent on this kind of research could be expended much more profitably in strengthening the teaching work. It is unnecessary to debate the correctness of the writer's judgment as to the quality of the research work done in the universities. A large part of the research work done everywhere is mediocre or poor and it would be surprising indeed if this did not imply also to the colleges. No doubt the work done in some institutions is inferior to that of some others just as the teaching is of different degrees of perfection. It seems, however, that the writer has entirely overlooked one aspect of research work which in the colleges should be given the most serious consideration.

For many years the appreciation of the value of research has been growing in this country. This interest has been greatly stim-